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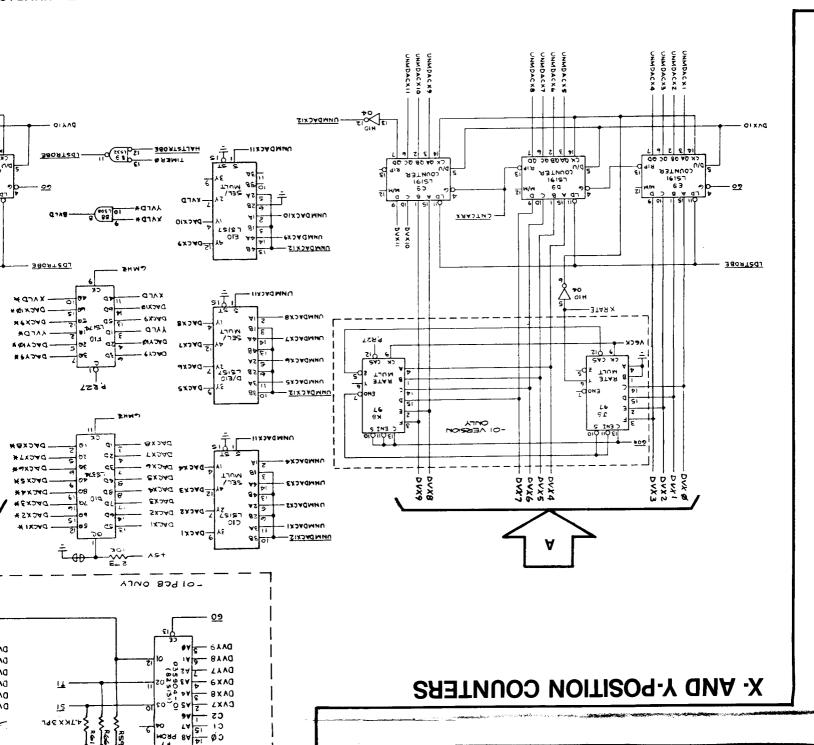
Sheet 2, Side A

ASTEROIDS DELUXE<sup>TM</sup>
Video Generator
Section of 036471-01 and -02
D

DACX1 thru UNMDACX10 (X-axis unmultiplexed digital-to-erter signals) are transferred and atored at the output of serior of the output of the G-MHz clock (from the terror on each rising edge of the 6-MHz clock (from the terror or each rising edge of the 6-MHz clock (from the digital-to-analog converters (DACX1 thru DACX10 signals are on the monitor. The far left of the monitor acreen is 0, the on the monitor. The far left of the monitor beam would go off and the far right is 1023. Therefore, if the DACX1 thru has greater than 1023, the monitor beam would go off so of the screen and start again on the left side of the wasparound, condition. To prevent a wraparound, the wasparound, condition. To prevent a wraparound, the steet input from UNMDACX11 goes high when the after than 1023 or less than 0. This selects UNMDACX12 to on the multiplexers to the DACs, forcing all zeros or all on the Reeping the beam on the appropriate side on the province of the page.

and of allowing it to wraparound. It and YVLD (X and Y valid) outputs from the X- and sunter multiplexers are latched (F10) and gated together to axis output, BVLD (beam valid).

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The DACX1 at sent to the digit microcomputer the multiplexers analog converte The UNMDAC

Y-position count The XVLD at screen, instead oues' and thus be output from count is greater multiplexers' se screen, a "wra the right side o r Isngis OfXOAD center is 512, a of the beam on t

enable the Z axi

generator memory data latches. 12-bit number (DVX0-11) is loaded into the counters from the vector

pulses the counters will receive and whether the counters will count This data contains information that determines how many clock mined by DVX0-11 (from the vector generator memory data latches). vector to be drawn relative to the beam's current position is deterscreen. The direction (to the left or right) and length (0 to 1023) of the tensity. This is the procedure used to draw a vector on the monitor During this beam movement, the beam is turned on with the desired into the left or to the right a specific distance relative to where it was. down any specific number of counts. This will cause the beam to move The state machine can also instruct these counters to count up or

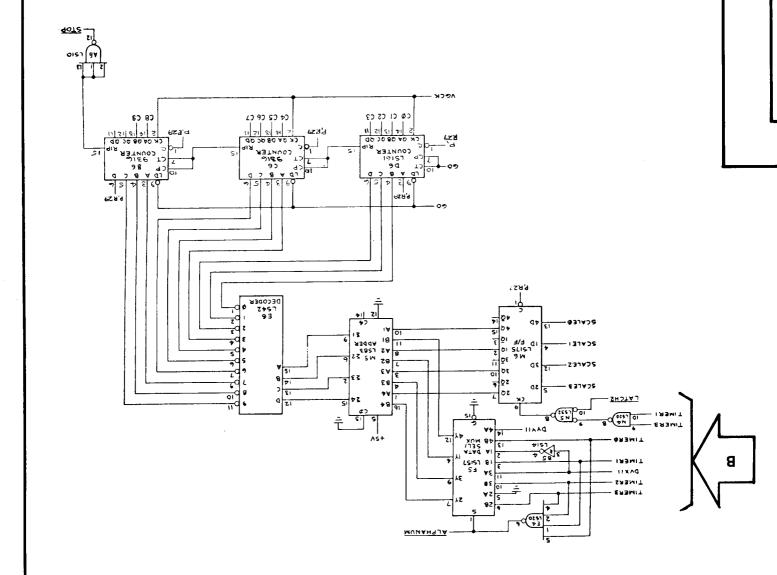
vector being drawn. the counters count up or down. DVX11 determines the quadrant of the 11 are loaded directly into the counters. DVX10 determines whether will still be displayed with the same relative beam intensity. DVX10 and draw the desired vector. This insures that vectors of different lengths clock pulses at equal intervals over the time period that it will take to function of these devices is to space the desired number of counter DVX0-9 memory data is loaded into rate multipliers 18 and K8. The

> ters (C9, D9 and E9), multiplexers (C10, D/E10, E10), latch tion counters contain rate multipliers (18 and K8), description discusses only the X-position counters. '-position counters are two identical circuits. Therefore,

> that data to alter the binary count of these counters in decodes instructions from its memory, and then is cato the right or left, respectively. The vector generator decreasing this binary number output will cause the screen and 1023 being the far right side of the screen. m on the monitor screen (or X axis), with 0 being the far 12-bit binary number that represents the horizontal locaociated gates (B8 and H10). The output of the down/up

> rator causes **LDSTROBE** to go low. At this time, a new he screen. To preset this new position into the counters, neam itself is turned off to prevent unwanted lines from ector ended. While the beam is "jumping" to this new new vector from a different starting position than where w location on the monitor screen instantaneously, i.e., their previous contents. This will cause the beam to achine can preset these counters to an entirely different





The purpose of the vector timer is to time out the length of time it takes to "draw" an actual vector on the monitor display. During the interval when the X- and Y-position counters are actually drawing the vector, <u>STOP</u> is high. This prevents the vector-generator state machine from advancing to its next state until the vector currently being drawn is completed. As soon as the vector has been drawn, <u>STOP</u> goes low, allowing the state machine to advance to the next state in its intended sequence.

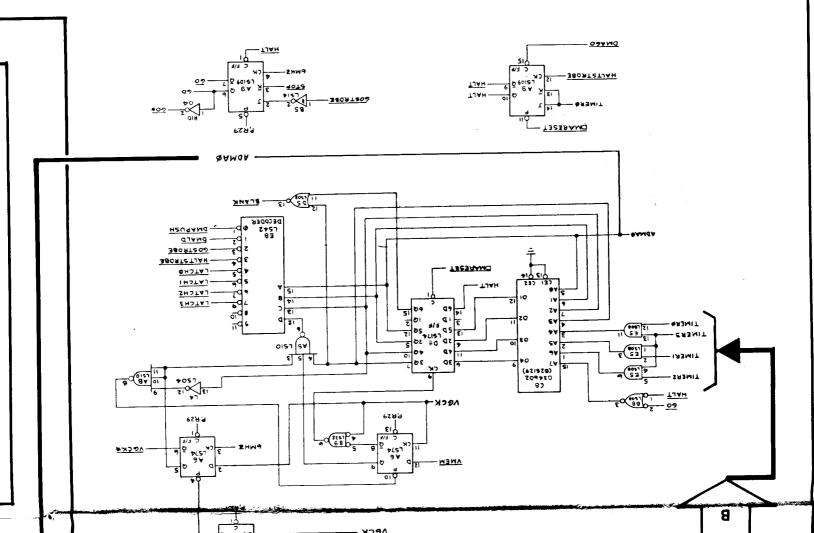
The vector timer consists of multiplexer F5, decoder E6, latch M6, adder M5, and counters B6, C6, and D6. M6 contains a scale factor which is added in M5 to the four timer signals. If TIMER0 thru TIMER3 inputs are any state but all high, decoder E6 directly decodes the sum and loads the decoded low into one of the counters. When GO goes low, the counters count from the loaded count nutil the counters all reach their maximum count. This count is a maximum length of 1024. At this time STOP goes low and clears the GO flip-flop of the state machine.

If the TIMER signals are all high,  $\overline{\text{ALPHANUM}}$  goes low and data signals DVX11 and DVY11 are decoded by decoder E6. This is added to the scale factor and loaded into the counters.

appearing on the s position, the beam the previous vecto for drawing a new "jump" to a new lo number from thei The state machi one of two ways. pable of using tha state machine dec beam to move to Increasing or deci left side of the scr tion of the beam o counters is a 12-bi (F10), and associal down/up counters The X-position the following desc

The X- and Y-pos

the state generato



The microcomputer outputs an address that results in a <u>DMAGO</u> signal that causes <u>HALT</u> to go high, and clears the vector-generator data latches. This makes TIMERO thru TIMER3 signals all low. The state machine now begins executing instructions, starting at vector memory location 0.

When the state machine receives the operation code for a HALT struction, it outputs a low HALTSTROBE, setting the HALT flip-flop A9, and suspending state machine operation.

The GO signals load and enable the vector timer and the X and Y position counters and tell the ROM that the vector generator is now actively drawing a vector. The HALT input to GO flip-flop A9 sets the outputs to ensure that the vector timer and position counters are not active when the state machine is that the counters are not active when the state machine is for timer and X- and Y-position counters begin to operate from the GO, GO and GO\* signals. When STOP is clocked through A9, the vector timer has reached its maximum count, and GO goes high. This means the vector has been drawn.

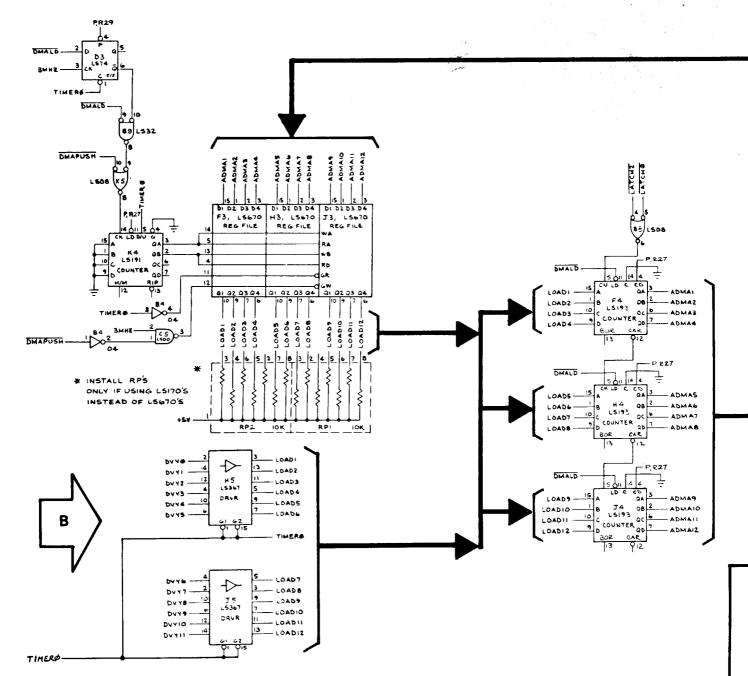
The VGCK input to the clock circuitry is a buffered 1.5MHz clock signal from the microcomputer. This is the same frequency used to clock the MPU of the microcomputer. The signal clocks latch D8 unless the microcomputer is addressing the vector RAM or ROM memories (when VMEM goes low). Then the clock input to latch D8 goes high and stays high until VMEM goes high.

The state machine is the "master controller" of the vector-generator circuitry. It receives instructions from the game tions by accessing the appropriate sections of the vector-generator program erator ROM memory, using the vector-generator program counter to do so. The state machine reads the vector-generator ROM data (via Timer 0-3) and decodes this information to determine how it should use this data: 1) to draw a vector; 2) to move the monitor beam to a new position on the monitor display; 3) the monitor beam to a new position on the monitor display; 3) to be with the monitor beam to a new position on the monitor display; 3) be vector memory address; 4) to return to a to "jump" to a new vector memory address; or 5) to tell the game MPU previous vector memory address; or 5) to tell the game MPU previous vector memory address; or 5) to tell the game MPU that it has completed its current instructions, and is waiting for the next command.

The state machine consists of input gates B8 and E5, ROM C8, latch D8, clock circuitry A6, and decoder E8. Four-bit input TIMER0 thru TIMER3 is the operation-code input to the state machine. The A4 thru A6 address input to ROM C8 tells the ROM which instructions to perform. Address inputs A0 thru A3 from latch D8 tells the ROM which state was last performed. The address A7 input GO tells the ROM that the position counters are presently drawing a vector. The HALT input to A7 tells the ROM that the vector generator has completed its operations.

During initial power-up of the game, the HALT signal is preset low. The microcomputer reads the high HALT signal through its switch input port (sel/mux L10) on data line DB7. This tells the microcomputer that the vector generator is halted and waiting for an instruction. To ensure that the beam is off when the state machine is halted, the high HALT, clocked is off when the state machine is halted, the high HALT, clocked through latch D8, results in a low BLANK to the Z-axis output.

## PROGRAM COUNTER



Counters F4, H4 and J4 contain the address of the next data byte (instruction) to be fetched from the Vector Generator memory. Because these counters point to the next instruction in memory to be retrieved and performed, they are called the program counter. This program counter is incremented one count (to the next sequential address) each time the information at its current address is loaded into data latch 0 or data latch 2.

The program counter may also be preset to "jump" to a new address. This new address can be loaded into the program counter from the vector generator memory via data latches F6 and H6 and buffers H5 and J5.

The program counter may also be preset to "return" to a previous address which it had stored in its "stack". The stack consists of register files F3, H3, & J3, and down/up counter K4. The stack is a 4-word 12-bit memory, used to save the contents of the program counter for future reference. It is loaded when DMAPUSH is low. Immediately after information is written into the stack, counter K4 increments one count. Immediately before loading the program counter from the stack, counter K5 decrements one count.

## STATE MACHINE

